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AUTHOR Bitner, Betty L.

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ABSTRACT

Investigated as predictors of preservice elementary teachers' attitudes toward the teaching of science were scores on the science subtests of the C-BASE and ACT, number of college science hours, and college GPA. The Science Attitude Scale for Preservice Teachers, measuring comfort/discomfort of teaching science, science as a basic need, time required to prepare and to teach science, and handling of science equipment, was administered to the sample (N=210) during the first week of the elementary science methods class. The stepwise regression yielded C-Base science and college science hours as predictors of attitude toward teaching science. (The Science Attitude Scale for Preservice Teachers is contained in the appendix. (Contains 33 references.) (Author)

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ACT SCIENCE, C-BASE SCIENCE, COLLEGE SCIENCE HOURS, AND GPA: PREDICTORS OF PRESERVICE ELEMENTARY TEACHERS' ATTITUDES TOWARD THE TEACHING OF SCIENCE

Betty L. Bitner

Department of Curriculum and Instruction
205-D Hill Hall
Southwest Missouri State University
901 S. National Ave.
Springfield, MO 65804

(417) 836-5137 or 6376
BITNET: BEB105f@SMSVMA
FAX#: 417-836-4884

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Paper presented at the annual meeting of the National Association for Research in Science Teaching April 19, 1993, in Atlanta, GA.

Abstract

Investigated as predictors of preservice elementary teachers' attitudes toward the teaching of science were scores on the science subtests of the C-BASE and ACT, number of college science hours, and college GPA . The Science Attitude Scale for Preservice Teachers, measuring comfort/discomfort of teaching science, science as a basic need, time required to prepare and to teach science, and handling of science equipment, was administered to the sample (N = 210) during the first week of the elementary science methods class. The stepwise regression yielded C-Base science and college science hours as predictors of attitude toward teaching science.

Purpose of the Study

In this study, the C-BASE science score, ACT science score, total number of college science hours, and college GPA were investigated as predictors of preservice elementary teachers' attitudes toward the teaching of science.

Significance of the Study

"Students in elementary school have spontaneous interest in nature and numbers" (AAAS, 1989, p. 135). However, approximately one-third of all students dislike science by the end of third grade (AAAS, 1989; Harty & Enochs, 1985), and only one-fifth enjoy science by the end of fifth grade (Harty & Enochs). A probable underlying factor of these results is science anxiety or negative attitudes toward science (Mallow, 1981a, 1981b). Negative attitudes toward science begin before college entrance (Mallow, 1981b). He reported that the type of thinking science demands and the type of thinking which is taught are incongruous. Science in

the elementary and secondary school is taught as memorization of facts, principles, and theories and convergent thinking he claims. He advised analysis and synthesis are needed to do science; therefore, divergent thinking must also be taught. Zeitler (1984) reported that preservice teachers indicated teaching of science information not science processes as the major purpose for elementary science and yet these teachers believed their science backgrounds were inadequate. Bitner's (1992) findings indicated that preservice elementary teachers have very favorable attitudes toward teaching science. Those teachers were especially supportive of teaching science as process, laboratory science, and science as a basic. She attributed these favorable attitudes to the practices of hands–on experiences and the developmental approach to learning in the Teacher Education Program for preservice elementary teachers and to the constructivist process used by two professors who teach science courses for non–majors. Positive attitudes toward teaching science were also found by Schoeneberger and Russell (1986). Reasons given were a degree in biology at the undergraduate and graduate levels, experience teaching science, and participation in science workshops. These same teachers were frustrated because they (a) lacked needed equipment to teach required curriculum, (b) allotted little time to teaching science because science was not considered a basic in their schools as recommended by Mechling &

Oliver (1983), and (c) felt compelled to spend time on reading and mathematics to accommodate the preponderance of students with problems in these areas.

History indicates that science is "a male profession" (Rossiter, 1982, p. 74), and studies (e.g., Czerniak & Chiarelott, 1985; Shrigley & Johnson, 1974; Willson; 1983) revealed male attitudes toward science and science teaching to be somewhat more favorable. Many females consider themselves unqualified to teach science (Berger, 1982; Orlich, 1980); however, a preponderance of elementary teachers are women (Mallow, 1981b).

Attitude, labeled emotional intensity (Shrigley & Koballa, 1984), toward science and science teaching affects whether science is taught, how it is taught, and how much it is taught (Gabel & Rubba, 1979; Harty, Beall, & Scharmann, 1985; Koballa & Crawley, 1985; Mechling & Oliver, 1985; Riley, 1979; Shrigley, 1974; Shrigley & Johnson, 1974; Thompson & Shrigley, 1986). "Attitudes and behavior are correlates" (Shrigley, 1990, p. 97). Negative attitudes toward science and science teaching can be changed by fostering positive attitudes in both genders as a result of success in science process skills and manipulation of science equipment from kindergarten through college (Barrow, Holden, Bitner, & Kane, 1986; Bitner, Nichols, & Kane, 1984; Harty et al., 1985; Gabel & Rubba, 1979), in high school and college science courses (Schoeneberger & Russell,

1986; Stefanich & Kelsey, 1989; Westerback, 1982), in preservice science education courses (Lucas & Dooley, 1982; Riley, 1979; Shrigley, 1974; Westerback, 1982; Westerback, Gonzalez, & Primavera, 1985), and in inservice science education courses (Bitner, 1987, 1990; Schoeneberger & Russell, 1986; Shrigley, 1983; Shrigley & Johnson, 1974). In particular, Lucas and Dooley's and Stefanich and Kelsey's findings should be noted. Lucas and Dooley reported that the science methods courses but not the science content courses had positive effects on the teachers' attitude toward the teaching of science. Stefanich and Kelsey found university students who completed two basic science courses for elementary teachers, one in physical science and another in biology, as well as the two general education courses in science before enrolling in the elementary science methods course had more favorable attitudes than those students who had completed only the two general education courses.

Preservice elementary teachers cited prior science learning experiences and field experiences as sources of negative beliefs about science teaching (Jasalavich, 1992). Teachers with 36 credit hours of science described science instruction as a process of giver of knowledge and receiver of knowledge, the mode of instruction for the science courses completed, but indicated that they learn best when they can ..."work with the strategy and implement it and make it go, you

know, change, adjust it to meet my needs, then I'm going to remember it. I find that I know more if I can work with stuff." (Jasalavich, p. 26) Based upon their field experiences, these preservice teachers concluded that doing hands-on science was "too time consuming...you've got to get through everything that's in the book. (p.27)

Design and Procedures

Design

Sample

The population for this predictive study consisted of preservice elementary teachers enrolled in "Teaching Science in the Elementary School" at in a midwestern university with a student enrollment of approximately 20,000. The Teacher Education Program has an enrollment of approximately 3,300 graduate and undergraduate students. Of those, approximately 1,279 are preservice elementary education majors. For admittance into the Teacher Education Program, students must have completed 45 credit hours with a GPA of 2.4, an American College Test (ACT) composite of 20, and a College Basic Academic Subjects (C-BASE) composite of 235. In the science area, elementary education majors are required to complete the elementary science methods course plus three science courses.

Approximately half of the population was selected as the sample. In the preliminary analysis of data, anyone who had not taken the C-BASE, was just enrolled at this university for the summer, or was an outlier in

any of the variables, was dropped from the sample. Therefore, the sample consisted of 210 preservice elementary teachers, 192 females and 18 males. Twenty-seven percent of the preservice elementary teachers had completed a physics course especially designed for elementary teachers. A constructivist process is used to teach the course.

Instrumentation

Prior to admittance to the Teacher Education Program, the preservice elementary teachers had taken the ACT and C-BASE. During the first week of classes, the Science Attitude Scale for Preservice Teachers (Thompson & Shrigley, 1986) was administered to approximately half of the preservice elementary teachers enrolled in the elementary science methods course over a three semester period.

Because the ACT is a widely used and accepted test for college entrance, the validity and reliability of the instrument will not be discussed. The mean is 20 with a standard deviation of six.

C-BASE, a criterion-referenced test, measures knowledge and skills in four academic areas, i.e., English, mathematics, science, and social studies (Osterlind & Mertz, 1990). It is used to assess the knowledge and competencies in the four academic areas covered in the general education component of an undergraduate degree program. The science component assesses laboratory and field work (i.e.,

observation/experimental design, laboratory/field techniques, and interpreting results) and fundamental concepts in life and physical sciences. The mean and standard deviation for the science component are 252 and 71.1, respectively. For information regarding the validity and reliability, refer to Osterlind and Mertz (1990).

The Science Attitude Scale for Preservice Teachers, consisting of 22 attitude statements (12 positive and 10 negative) and distributed among four subcomponents: "comfort–discomfort of teaching science" (1, 3, 6, 7, 9, 11, 14, 18, and 19); "basic need American students have for science" (2, 8, 15, 21, and 22); "time required to prepare and teach science" (4, 13, and 20); and " handling of science equipment" (5, 10, 12, 16, and 17), measures attitude toward the teaching of elementary school science (see Appendix).. For the 12 positive statements (i.e., 2, 5, 7, 8, 10, 12, 13, 15, 16, 18, 19, and 22), the ratings ranged from strongly agree (5) to strongly disagree (1). The reverse ratings, strongly agree (1) to strongly disagree (5), were used for the ten negative statements (i.e., 1, 3, 4, 6, 9, 11, 14, 17, 20, and 21), reflecting negative attitudes toward the teaching of science. The means and standard deviations of each subcomponent were: (a) comfort–discomfort (M = 30.9, SD = 5.9); (b) need (M = 18.8, SD = 3.2); (c) time (M = 11.2, SD = 6.4); and (d) equipment (M = 17.0, SD = 3.3). Thompson and Shrigley

reported a coefficient alpha of 0.89 for the Science Attitude Scale, 0.85 for the subscale of positive statements, and 0.75 for the subscale of negative statements. Convergent and divergent validities were established. The majority of the interitem correlations among the 22 statements were positive. The means on the 22 statements ranged from 2.63 (statement 18) to 4.59 (statement 21).

Content validity was established by correlating the four subcomponents and by using a principal components analysis to extract the common factors. The intercorrelations among the four subcomponents yielded coefficients ranging from 0.46 to 0.70. In the principal components analysis of the revised 22 statement attitude scale, factors generating eigenvalues 1.00 or higher were rotated and revealed four major factors, explaining 62.08% of the variance. Assignment of the statements to a factor was based on the loading of 0.60 or higher on that factor and 0.35 or lower on the other three factors: therefore, statements 5, 7, 10, 12, 13, 19, 20, and 22 loaded on Factor 1; statements 3, 9, 11, 16, and 17 on Factor 2; statements 1, 14, and 18 on Factor 3; and statement 21 on Factor 4. Five statements (2, 4, 6, 8, and 15) failed to load on any of the four factors. Thompson and Shrigley claimed that they did not anticipate loadings on the four factors to match the four subcomponents: comfort-discomfort, need, equipment, and time.

Statistical Analysis of Data Procedures

Thompson and Shrigley (1986) advised that for a Likert-type attitude scale to be evaluative in nature it should have (a) a mean between 2.00 and 4.00 with a standard deviation hovering around 1.00; (b) neutral responses below 35%; and (c) non-skewed distribution. Neutral statements beyond 35% connote vagueness or ambiguity; skewed distributions imply a factual level. In reporting the results of the Science Attitude Scale in this study, therefore, the above criteria were used. Frequency and multiple regression programs (SPSS, 1990) were used to analyze the data. Means, standard deviations, and neutral responses were computed on the Science Attitude Scale for Preservice Teachers. The stepwise regression analysis was used to determine how much variance in the total attitude score and the the four attitude subcomponent scores was accounted for by the independent variables. Tolerance (0.0001), PIN (0.05), and POUT (0.10), the default criteria for the stepwise regression established by SPSS (1990), were specified for the regression analysis. A 95% confidence level was established for determining significance of a regression coefficient (Achen, 1982; Norusis, 1990). Scatterplots of the regression equations were analyzed to determine whether the assumptions of normality, homogeneity of variance, statistical independence of the dependent variables, and linearity, indicating no relationship between the predicted and residual values,

Insert Table 2 about here

the sample had scores below 20; 2% scored 30 or above.

The mean and standard deviation on the C-BASE Science were 323.75 and 47.38 (see Table 3). Only 3% scored below the norm group mean of 252. Ten percent of this sample scored two standard deviations above the norm group mean of 252.

Insert Table 3 about here

The mean GPA and standard deviation were 3.25 and .42. As previous noted, the GPA required for admittance into the Teacher Education Program is 2.4. In general, students enrolled in the elementary science methods course had already completed a general methods, foundation courses, and even other special methods courses.

Means, Standard Deviations, and Percent of Neutral Responses on Science Attitude Scale

In Table 4 are reported the means, standard deviations, and percent of neutral responses on the Science Attitude Scale. The mean for the sum of positive statements was 47.41 (SD = 5.74), with a possible range from most positive (60) to least positive (12). A rating of five is most positive; a rating of

one is least positive. The mean for the negative statements was 37.14 (SD = 5.56) with the range from least negative (50) to most negative (10). A rating of five is least negative; a rating of one is most negative. The only statement with neutral responses exceeding 35% was 7. As recommended by Thompson and Shrigley (1986), no means fell below 2.00 and the standard deviations hovered around 1.00, but 10 means did exceed 4.00 (statements 2, 4, 5, 9, 13, 15, 19, 20, 21 and 22). Four of the five statements in the subcomponent need had means beyond 4.00 recommended by Thompson and Shrigley (1986); the mean for this subcomponent was 21.14. All three of the statements in the subcomponent time had means greater than 4.00; the mean for the time subcomponent was 12.72.

Insert Table 4 about here

ACT Science, C-BASE Science, College Science Hours and GPA: Predictors of Preservice Elementary Teachers' Attitudes toward the Teaching of Science

As presented in Table 5, the C-BASE science score and college science hours were found to be statistically significant predictors of attitude toward the teaching of science. The other independent variables did not

meet the criteria for entry into the regression equation.

Insert Table 5 about here

The following results of the stepwise regression equations were found when the subcomponents on the attitude scale were dependent variables. College science hours followed by C-BASE science score predicted "comfort–discomfort of teaching science" (see Table 6).

Insert Table 6 about here

The only statistically significant predictor of "basic need American students have for science" was the ACT science score (see Table 7). In fact, the other independent variables did not meet the criteria for entry into the regression equation.

Insert Table 7 about here

For the subcomponent "time required to prepare and teach science," none of the independent variables met the criteria for entry into the regression equation. C-BASE science score and college science hours predicted "handling of science equipment" (see Table 8).

Insert Table 8 about here

Conclusions and Recommendations

Because of the overall findings in the review of literature, all independent variables, except perhaps GPA, were anticipated to be significant predictors of attitude and the subcomponents of attitude as measured by the attitude scale. However, only the C-BASE science score followed by the number of college science hours were significant predictors of the total attitude toward science teaching and subcomponent "handling of science equipment." College science hours followed by C-BASE science score contributed the most variance in the subcomponent comfort-discomfort in teaching science. As noted, the C-BASE and college science hours were statistically significant predictors of the preservice teachers attitude toward science, but the total amount of variance explained by the two variables is small (5-8%). These findings corroborate those of Schoeneberger & Russell (1986) Stefanich & Kelsey (1989), but conflict with Jasalavich's (1992) results that preservice elementary teachers with 36 credit hours of science view science instruction as primarily that of disseminating knowledge. Why only ACT science score met the criteria for entry into the regression equation for the subcomponent "basic need American students have for

science" cannot be explained. If ACT science score predicts this subcomponent, it seems plausible that C-BASE science score and number of college science hours should also predict it.

The sample had rather positive attitudes toward the teaching of science. In fact, four of the five statements in the subcomponent need and all three of the statements in the subcomponent time had means beyond 4.00 as recommended by the attitude scale developers. Therefore, one might conclude that those statements are more factual than evaluative in nature.

Why did this sample have such positive attitudes toward the teaching of science? The science methods course as recommended by Lucas and Dooley (1982) could not be the reason for the positive attitudes because students completed the attitude scale during the first week of the methods course. Perhaps the emphasis on hands-on and developmental approach to learning (constructivist process) in the Teacher Education Program influenced the preservice teachers' attitudes, which might explain why the means of statements relating to processes, manipulation, equipment, etc., were high. Another possibility is that 24% of the preservice teachers had completed more than 12 hours in science. Also, 27% of them had completed a physics course for elementary teachers, in which the constructivist process is used, thereby providing one basic science course beyond the general education science courses. These

results support Stefanich and Kelsey's (1989) finding that university students with two basic science course for elementary teachers beyond the two science courses required for general education had more favorable attitudes toward science than students with only the two general education science courses. Also the scores on the ACT science subtest (only 20% below the mean) and C-BASE science subtest (only 3% below the mean) indicate that most of the sample either met or exceeded the means for the norm groups on these two tests.

Further study is needed. It is recommended that a causal-comparative study be conducted to compare the attitudes of preservice teachers who have completed the physics course, especially designed for elementary teachers, with those who have completed only regular general education science courses. Also, differences in attitude according to scores on the ACT and C-BASE and to the number of college science hours could be investigated. The author also plans to submit data on a larger sample to a principal components analysis to determine if results similar to Thompson and Shrigley are found.

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Table 1

Means and Ranges of College Credit Hours in Science (N = 210)

	M	Range	≤ 3	4-8	9-12	> 12
Earth	2.74	14	80%	14%	4%	2%
Physical	4.18	16	15%	81%	3%	1%
Life	4.60	20	4%	92%	2%	2%
Total	11.50	28	0%	16%	60%	24%

Table 2

Means, Standard Deviations, and Percentages above and below Required ACT Score of 20 (N = 210)

M	SD	< 20	20–25	26–29	30 or >
22.61	2.53	20%	68%	10%	2%

Table 3

Means, Standard Deviations, and Percentages above and below Norm Group Mean of 252 on C-BASE (N =210)

M	SD	< 252	252–300	301–350	351–393	394 or >
323.75	47.38	3%	30%	39%	18%	10%

Table 3

Means, Standard Deviations, and Percentages above and below Norm Group Mean of 252 on C-BASE (N =210)

M	SD	< 252	252–300	301–350	351–393	394 or >
323.75	47.38	3%	30%	39%	18%	10%

Table 4
Means, Standard Deviations, Neutral Responses on Attitude Scale (N = 210)

			Neutral Responses	
STATEMENT	M	SD	f	%
1. Uncomfortable[a]	3.50	1.02	49	23
2. Processes[b]	4.58[f]	0.73	0	0
3. Fear[a]	3.43	1.04	34	16
4. Time[c]	4.31[f]	0.69	12	6
5. Lab[d]	4.16[f]	0.92	26	12
6. Difficult[a]	3.53	1.07	12	6
7. Content[a]	3.37	0.91	88	42[e]
8. Experimental[b]	3.75	0.85	50	24
9. Dread[a]	4.10[f]	0.87	19	9
10. Phenomena[d]	3.82	0.87	39	19
11. Forward[a]	3.91	0.94	20	9
12. Construct[d]	3.99	0.76	23	11
13. Equipment[c]	4.19[f]	0.60	9	4
14. Questions[a]	2.60	1.08	33	16
15. Important[b]	4.20[f]	0.71	21	10
16. Manipulating[d]	3.71	0.86	45	21
17. Expected[d]	3.02	1.01	38	18
18. Preferred[a]	3.07	1.12	56	27
19. Excite[a]	4.50[f]	0.53	0	0
20. Effort[c]	4.23[f]	0.57	15	7
21. Curious[b]	4.53[f]	0.79	3	1
22. Integrate[b]	4.08[f]	0.77	30	14
Positive Statements	47.41	5.74		
Negative Statements	37.14	5.56		
Four Subcomponents				
Comfdis	32.00	5.62		
Need	21.14	2.31		
Time	12.72	1.43		
Equip	18.70	3.11		
Total Attitude	84.56	10.45		

Note. Positive statements include 2, 5, 7, 8, 10, 12, 13, 15, 16, 18, 19 and 22. The ratings for these statements are SA = 5, A = 4, N = 3, D = 2, SD = 1.
Note. Negative statements include 1, 3, 4, 6, 9, 11, 14, 17, 20, and 21. The reversed ratings for these are SA = 1, A = 2, N = 3, D = 4, SD = 5.

[a]Subcomponent comfort/discomfort (9 statements).
[b]Subcomponent need (5 statements).
[c]Subcomponent time (3 statements).
[d]Subcomponent equipment (5 statements).
[e]Exceeded 35% neutral responses.
[f]Outside 2.00–4.00 range of mean.

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Table 5

College Science Hours, ACT Science, C-BASE Science, and GPA: Predictors of Preservice Elementary Teachers Attitudes toward Teaching of Science (N = 210)

	Total Attitude				
Step	Predictors	R	R^2	F	P
1	C-Base Science	.22	.05	10.40	.0015
2	Science Hours	.29	.08	9.55	.0001

Note. ACT science subtest score and G.P.A. did not meet the criteria for inclusion into the regression equation.

Table 6

College Science Hours, ACT Science, C-BASE Science, and GPA: Predictors of Preservice Elementary Teachers' Attitude Subcomponent Comfort/Discomfort toward Teaching of Science (N = 210)

		Attitude (Comfort/Discomfort)			
Step	Predictors	R	R^2	F	P
1	Science Hours	.26	.06	14.56	.0002
2	C-BASE Science	.33	.11	12.90	.0000

Note. ACT science subtest score and G.P.A. did not meet the criteria for inclusion into the regression equation.

Table 7

College Science Hours, ACT Science, C-BASE Science, and GPA: Predictors of Preservice Elementary Teachers Attitude Subcomponent Need toward the Teaching of Science (N = 210)

		Attitude (Need)			
Step	Predictors	R	R^2	F	P
1	ACT Science	.18	.03	7.18	.0080

Note. Total science hours, C-BASE science, and G.P.A. did not meet the criteria for inclusion into the regression equation.

Table 8

College Science Hours, ACT Science, C-BASE Science, and GPA: Predictors of Preservice Elementary Teachers Attitude Subcomponent Equipment toward the Teaching of Science (N = 210)

		Attitude (Equipment)			
Step	Predictors	R	R^2	F	P
1	C-BASE Science	.18	.03	7.12	.0082
2	Science Hours	.23	.05	5.75	.0037

Note. Total science hours, ACT science subtest score, and G.P.A. did not meet the criteria for inclusion into the regression equation.

SCIENCE ATTITUDE SCALE

This instrument is designed to assess your attitudes toward teaching science. Please consider each statement and blacken in the space on the answer sheet that corresponds to your degree of agreement with the statement.

A=Strongly Agree; B=Agree; C=Undecided; D=Disagree; E=Strongly Agree

1. I will feel uncomfortable teaching science. **(negative, comfort/discomfort)**
2. The teaching of science processes is important in the elementary classroom. **(positive, need)**
3. I fear that I will be unable to teach science adequately. **(negative, comfort/discomfort)**
4. Teaching science takes too much time. **(negative, time)**
5. I will enjoy the lab period in the science courses that I teach. **(positive, equipment)**
6. I have a difficult time understanding science. **(negative, comfort/discomfort)**
7. I feel comfortable with the science content in the elementary school curriculum. **(positive, comfort/discomfort)**
8. I would be interested in working in an experimental science curriculum. **(positive, need)**
9. I dread teaching science. **(negative, comfort/discomfort)**
10. I am not afraid to demonstrate science phenomena in the classroom. **(positive, equipment)**
11. I am not looking forward to teaching science in my elementary classroom. **(negative, comfort/discomfort)**
12. I will enjoy helping students construct science equipment. **(positive, equipment)**
13. I am willing to spend time setting up science equipment. **(positive, time)**
14. I am afraid that students will ask me questions that I cannot answer. **(negative, comfort/discomfort)**
15. Science is as important as the 3R's. **(positive, need)**
16. I enjoy manipulating science equipment. **(positive, equipment)**
17. In the classroom, I fear science experiments won't turn out as expected. **(negative, equipment)**
18. Science would be one of my preferred subjects to teach if given a choice. **(positive, comfort/discomfort)**
19. I hope to be able to excite my students about science. **(positive, comfort/discomfort)**
20. Teaching science takes too much effort. **(negative, time)**
21. Children are not curious about scientific matters. **(negative, need)**
22. I plan to integrate science into other areas. **(positive, need)**

Thompson, C., & Shrigley, R.L. (1986).

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